

SPOKEN LANGUAGE DEVELOPMENT IN A PRELINGUALLY DEAF CHILD
WHERE TOTAL COMMUNICATION WAS USED PRIOR TO COCHLEAR IMPLANTATION

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Abstract

Brain development is rapid in the early years of life and access to language is critical. Cochlear implant technology is changing access to spoken language for deaf children, with infants as young as 8 months old being implanted. However, there are cases where children awaiting implantation do not receive access to language for more than a year of life. This case study documents the language development of one child whose family exposed him to a flexible Total Communication approach prior to implantation. The purpose of the study was to observe the extent to which exposure to signs and gestures supported the development of spoken language and concept development both prior to and after implantation at the age of 16 months. Results indicated that the child's transition from a TC approach to spoken language was natural and smooth, resulting in age appropriate spoken language, concept development and expressive vocabulary.

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Introduction and Research Questions

The field of deaf and hard of hearing education exists primarily to support deaf and hard of hearing students and their families, as children acquire language and literacy skills for the purpose of achieving success in a primarily hearing world. The best approaches to facilitate language acquisition for this unique population have been a source of discussion and debate for at least a century. Part of the debate centers around the question of whether the use of sign language has a detrimental effect on the development of spoken language or literacy skills. Language development may be delayed in deaf and hard of hearing individuals because they receive access to language in limited quality and quantity. Depending on hearing loss, some children may only hear prosody or vague intonation patterns (Ertmer & Inniger, 2009). Paired with speech reading, this access to language would obviously limit a person's ability to learn to speak and enunciate clearly. It is the challenge of deaf educators, as well as specific therapists and researchers, to evaluate and determine appropriate methods of language acquisition for each individual deaf and hard of hearing student.

Two polarized schools of thought have existed in deaf and hard of hearing education: oralism and manualism. Proponents of oralism include those who support the use of auditory technology such as hearing aids and cochlear implants. Using audition through technology and learning to listen is supported by educators, speech language pathologists and auditory-verbal therapists the world over. An opposing theory of language acquisition recommends a visual approach, primarily supported by members of Deaf Culture. Proponents of this approach believe that a visual language, such as American Sign Language, is the natural and preferred language of communication for deaf and hard of hearing individuals, and that use of this approach will produce positive language and cognitive development (Corina, & McBurney, 2001; Courtin, 2000; Wolkomir, 1992). Although there are also communication approaches in which signing and speaking are combined, in Ontario, the field tends to be quite polarized in terms of proponents of a very strong auditory approach, or a very strong visual approach. When given information about choosing a communication method for their child, hearing families who do not use a visual language tend to expect that their deaf or hard of hearing child would most benefit from learning to use a spoken language in the hearing world. As a result, and with the advent of improved cochlear implant technology, more and more families

with severe to profoundly deaf toddlers are choosing to enroll in cochlear implant programmes such as at the Hospital for Sick Children in Toronto, Canada.

Since May 2002, in Ontario, the field has encountered many changes since the Infant Hearing Program began testing babies at birth (Hyde, 2002). This early identification of hearing loss has accelerated the need for research to determine whether age of implantation affects the natural acquisition of language. In Ontario, profoundly deaf children are reported to be routinely implanted by around 1 year of age (Papsin & Gordon, 2007). However, there are still issues that are concerning regarding access to language when the cochlear implantation is delayed, and technology is not in use. There are the few who are not implanted early because of the small circumference of their heads, other various health issues or family circumstances. Some argue that none of these children should be exposed to any combination of gestures or sign language prior to implantation. Considering the amount of changes that occur in the brain during the first year of life, others would argue that exposing a child to any form of communication or stimulation would be beneficial (Kovelman, Shalinsky, White, Schmitt, & Bere, 2009; Loots, Devise, & Jacquet, 2005). There is not enough specific literature or research to support the possible benefits of exposing a child, prior to implantation, to a visual language. There exist, however, many claims that doing so would have a detrimental effect on a child's ability to use the implant and learn spoken language (Marschark & Hauser, 2008).

In Toronto, the cochlear implant hospital prescribes the commencement of auditory-verbal therapy for any child who is being considered for a cochlear implant. In auditory verbal therapy, children are taught to use their residual hearing to make sense of their world. The challenge for a child who has a profound enough loss to be a candidate for the implant, is that he/she often can barely access sound, even with a hearing aid (Fitzpatrick, Olds, Gaboury, McCrae, Schramm, & Durieux-Smith, 2012; Schwartz, Watson, & Backous, 2012). Therefore, during the time between diagnosis and implantation, the infant or toddler continues to be without access to language, unless they are fortunate enough to have been born into a signing family or have parents who go against the grain and begin to learn to sign themselves.

Total Communication is the middle ground on a continuum of mode of communication with signed languages such as ASL at one extreme and spoken language at the opposite extreme. As Mayer

(2012) describes, Total Communication can be misconstrued as representing a 'speaking and signing at the same time' or 'simultaneous communication' (SC). Really, Total Communication is "flexible" in that the mode of communication used reflects the needs of the users in all situations. If more signs are needed, then more are used. If spoken language is the goal, the users speak naturally and use signs as required along with a combination of gestures, body language, pictures or 3-D objects. Mayer notes that TC is a "perfect fit" for the population of deaf learners who are awaiting a cochlear implant, have been fit with one and are moving through the transition, or who continue to experience difficulty acquiring spoken language even after implantation. The nature of deaf and hard of hearing education in Ontario though, is such that there are fewer and fewer capable users of this type of a signing system. Also, TC as defined by Mayer differs from what has been historically described as Total Communication used in the 1970's and 1980's, when children did not have access to cochlear implants. In the past, while the term "Total Communication" described the use of audition and sign together, given that most children did not have cochlear implants, in reality, the use of audition by these children was often quite minimal.

I am a teacher of the deaf, qualified to teach through specialized education. I have worked as an itinerant teacher with school aged children in Northern Ontario. Presently and for the past decade, I have worked with newly diagnosed infants and toddlers and their parents. It was during one particularly challenging year in my professional experience that I felt moved to study further, the research and controversies that drive decision making in my field. I had a handful of students on my caseload with late diagnosis, who were delayed in acquiring a first language. They were participating in mandatory auditory-verbal therapy sessions prior to implantation and without substantial residual hearing. That year, I observed first-hand, the frustration of the families to communicate with their children as they were being forced to eliminate all signs and gestures from their interactions with their deaf children, even prior to implantation. The intense emotions and questions from the families have moved me to embark on this journey to explore and investigate certain questions involving this unique group of children.

In my thesis study, I documented the language development of a deaf child from a hearing family who used the just described Total Communication approach prior to receiving an implant and I investigated the implication of this on his language development trajectory. The purpose of the study was to compare

this child's language development to hearing peers, pre-implant using the TC approach, and post-implant using spoken English, from 7 months to 52 months of age.

Visual language used in hearing families as parents are learning to communicate to their deaf child cannot be described as American Sign Language (ASL). Families will typically use natural gestures combined with single signs or signed phrases taken from the established language of the Deaf Community (ASL). This type of visual communication, is combined with facial expression, context and spoken language to make up a type of visual language comparable to "motherese" and serves as a natural segue into spoken language post implant. While time between implantation and activation can vary, access to spoken language can be delayed far beyond two years. However, given that this family had chosen to provide their deaf infant with the TC approach which included all types of sensory stimulation while awaiting cochlear implantation, my hypothesis would be that this child's progress in spoken language post implantation would be similar to a hearing child's natural language development, despite delayed access to spoken language. The goal of this study was to study the extent that this was the case. Findings from this study have the potential to contribute to the literature on early identification for bilateral cochlear implantation and the use of a flexible Total Communication approach prior to cochlear implantation in support of the development of spoken language. I will focus on answering the following questions: to what extent was this deaf child's language development on track relative to hearing norms, and were there any notable delays in his spoken language development as a consequence of being exposed to a TC approach?

Background and Context

A literature review on the topic of spoken language development in deaf infants and toddlers using cochlear implants is peppered with the topic of Auditory Verbal Therapy (AVT). The philosophy suggests that using an auditory-only approach, even prior to implantation, is the norm and will deliver the expected outcome. Typically hearing children have access to all of their senses and pass through well-defined milestones in their language development. Historically, deaf children have demonstrated delayed spoken language development which caused a limiting of their social and linguistic skills needed for academic success (Vernon, 2005). Literature on critical periods and other factors affecting language development support arguments for earlier age of implantation to close the gap between hearing and deaf children (Moore, 2002; Sharma, Dorman, & Spahr, 2002). However, theoretical frameworks of typical child development, such as Vygotsky's theory of language and thought may also support the possible advantages to using a visual language prior to implantation.

Disagreement in the field of deafness has not allowed families to proactively select a visual language or Total Communication approach for the "silent period" prior to implantation to close the gap. The Connectivist theory (Siemens, 2004) supports the notion of learning to access information from a variety of sources, emphasizing the importance of networked information resources throughout the learning process. In the following pages, each of these topics will be explored to develop the argument for the need for some type of visual language in order to nurture the infant's developing brain during unknown number of months prior to implantation.

Typical Language Development of Hearing Children

Language development begins in the womb, as the fetus has a developing ability to use its auditory system from approximately 4 months in utero. From that stage on, the child's mind is sourcing information about their world through all of their senses and begins to make connections in the brain partially based on what they hear. Newborns have demonstrated responses to pitch, rhythm and sound components of speech (Eimas, Siqueland, Jusczyk & Vigorito, 1971). Infants are said to prefer their own language compared to

a foreign language at two days of age, and at three days of age, infants are demonstrating preference for their mother's voice over a stranger's voice (Blakemore & Frith, 2007)

Babies develop many specific communication strategies very early on, and these are noted in various language development scales. From the early distinguishable cries of hunger, loneliness and pain, an infant can communicate needs and wants with their responsive caregiver in a remarkably effective way. Developmental milestones of speech become more prescriptive already in the early months of life as a child is expected to use specific speech sounds and intonation patterns in typical development. The auditory feedback loop describes the ability of the child to hear their own voice and adjust their speech sounds with obvious pleasure observable in their early babbling. By 8 months of age, children understand many words. They learn to imitate syllable sounds and intonation patterns before 6 months of age and recognize the need to pay attention to auditory clues in their environment signaling mealtime versus playtime (Rice, 1989).

Expressively, by 18 months of age, a hearing child with normal development can be expected to have a minimum of a 10 word vocabulary, speak two words together such as "alldone", imitate 2- word sentences and indicate objects in pictures. They are able to communicate needs and wants, share experiences and deliver humour. Receptively, these same children should understand directions which include action words such as "throw the ball", point to a large variety of pictures in a book, recognize common body parts and understand the common pronouns "you", "me", "mine" among other skills. Language development is well on its way by 18 months of age (Watkins, 1979).

Language Development of Children with Hearing Loss

Historically, children who have severe to profound hearing loss have followed varied paths in language development. Children born into Deaf families automatically use the signed language of the home and develop language in that modality following the same type of pattern as those learning a spoken language (Mahshie, 1995; Nicoladis, Mayberry, & Genesee, 1999). Children born into hearing families have often been encouraged to try hearing aid technology and are encouraged to use spoken language. Prior to the first pediatric cochlear implants in the late 1980's, full access to speech through hearing aids was generally not achievable, and so these children began the delayed acquisition of a visual language. There

has been much research to say that in the past, deaf children graduated high school on average with a grade four reading level (Holt, 1993; Traxler, 2000). While initially, only children older than 5 years were considered to be candidates for cochlear implants, by the mid to late 1990's, children began to be implanted as preschoolers. Some children could acquire language with intensive auditory verbal therapy, and speech often emerged around one year post implant, but the language development trajectory was slower than is seen today with infants who are implanted within 6 to 10 months after birth. These infants have early access to the four conditions outlined by Mayer (2007) for language acquisition: quality and quantity, accessible linguistic input, meaningful interactions, and capable language models.

Presently, studies show that children exposed to these favourable conditions through early implantation are demonstrating a reduced delay and are catching up to their age mates (Black, Hickson, Black, & Perry, 2011; Huber & Kipman, 2012; Waltzman, & Roland, 2005; Yoshinaga-Itano, 2003). The effects that this has had on academics have been stunning. The focus on language development prior to school entry has been supported through early identification and implementation of teacher of the deaf and hard of hearing services. There may be less need for support at the school level in terms of remedial speech teaching, vocabulary development, literacy support and additional curriculum modifications. This growing group of early identified, early bilaterally implanted deaf children are behaving very much like their hearing peers.

Later Implanted Children and Language Delays

With early cochlear implantation as the most common technological support for children with profound hearing loss in Ontario, there continues to be a small group of "exceptions to the rule" within that group. Early implantation is not always possible in cases where children have physiological issues that must first be resolved, while others have later diagnosis or progressive hearing loss which is undiagnosed (Black et al., 2011; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). There may be any number of additional extenuating circumstances that prevent a child from receiving an implant prior to their first birthday. During this time of silence, many children born into hearing families have also not had access to a visual language or the previously described Total Communication approach. Hearing aid technology has

perhaps benefited them by allowing access to prosody and intonation patterns; however, speech sounds fall within a 20 decibel to 60 decibel range, which for the most part, is far beyond the reach of children awaiting cochlear implantation. It can be assumed that most children receiving cochlear implants at 18 months or older have not had meaningful access to spoken language prior to that age. Compared to a hearing child at 18 months who can carry on simple conversations with a vocabulary of over 10 spoken words and many more vocal imitations, this language delayed cochlear implant candidate will look very much like the children of many years ago, who did not have the benefit of the technology (Loots, Devise, & Jacquet, 2005; Svirsky, Robbins, Kirk, Pisoni, & Miyamoto, 2000; Wheeler, Archbold, Watson, & Hardie, 2009). One might even argue that children of yesterday had more access to English than current late-implanted children, because the use of speech reading and English-based sign was widely encouraged.

Factors Affecting Language Development

There are four conditions outlined by Mayer (2007) necessary for language acquisition: adequate exposure to quality and quantity of language, accessible linguistic input, meaningful interactions and interactions with capable users of the target language. Deaf individuals may suffer on all four counts, depending on their familial situation or the counsel that their caregivers have followed. Even early implanted cochlear implant users may suffer from reductions in the quality and quantity of language, depending on the environmental sounds that the signal must compete with. Incidental learning is more difficult even in a quiet environment.

Accessible linguistic input refers to having technology that allows the language learner to hear the complete range of speech sounds, or have access to visual input to support that which may be lost in the speech signal. Studies have been done on the age of implantation and the effects that it has had on development of vocabulary, speech production and speech perception (Spencer, 2004; Tomblin et al., 2005). Children who are using cochlear implants prior to their first birthdays have been shown to demonstrate a quick “recovery” (Fallon, Irvine, & Shepherd, 2008). Marschark, Spencer, Adams & Saparon (2011) suggest that these children, on average (precluding any other obvious learning disability) are finding success academically following typical speech and language development. The authors write

that: “[children] who use cochlear implants demonstrate better language development and academic achievement than deaf peers without cochlear implants”(pg. 19).

As a result of early intervention programming, families are being mentored in methods of creating goal-directed meaningful interactions in everyday routines for the purpose of increasing vocabulary and language development (Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). This type of programming should ensure that children in most parts of Ontario are receiving the type of stimulation required for language acquisition, although there have been criticisms of the Ontario model with respect to service delivery (Cripps, & Small, 2004). The caregivers are given the opportunity to use whatever method of communication best suits their child from moment to moment. However, in reality, participation in auditory verbal therapy programs and a commitment to not using sign language is required at some cochlear implant programs. Personal experience suggests that bias against teachers working with the Ministry of Education’s home visiting program who are able to implement TC, exists.

There are some suggestions that children who attend regular auditory-verbal therapy programming post-implant succeed better than children who attend programs with combined modalities such as signing and speaking (Rhoades, 2004). Other researchers argue that modality, demographics and age of implantation are non-issues when it comes to developing consonant sounds and sign production (Seal et. al, 2011). A study done in Norway concluded that indeed there were predictors of speech production and recognition outcomes. They were: “amount of daily use of the implant, non-verbal IQ, and increased focus on oral communication in the educational setting, pre-operative hearing aid use, and duration of implant use” (Wie et al., 2007, pg. 241).

The fourth condition, rich interactions with others who are capable users of the target language, is seen when caregivers use their spoken language and pair it with signs, gestures and body language in natural communication with their child (Johnston, Durieux-Smith, & Bloom, 2005). Fear of being perfect is lessened by the flexibility of this TC approach (Mayer, 2012) and families can do what comes naturally to them, while at the same time, positively support language acquisition before and after implantation. Mayer’s perspectives on language development in children with hearing loss are solidly grounded in Vygotsky’s theories of language and thought (Vygotsky, 1962).

Vygotsky's Theory of Language and Thought

Child psychologists and teachers who study the way children learn and develop have long paid homage to Vygotsky's beliefs about the need for language to develop thought. Vygotsky believed that language and thought are interactive such that language shapes thought and thought shapes language (Vygotsky, 1962). Implications of this theory are highly concerning for educators of the deaf working with infants and toddlers who are awaiting their cochlear implant. If language is a tool for mediating thought, then is it possible that pre-implanted children who are unable to access spoken language are therefore "in waiting" while their minds are not exposed to language, and therefore mediated thought? How are these children making sense of their world? For 12 months or more, while the child attends auditory verbal therapy sessions and cannot hear anything meaningful auditorily, how are these profoundly deaf children communicating their needs with their parents?

Vygotsky explained that language is the mechanism of thinking. It makes sense that the connections made throughout the brain while attending to speech with visual cues facilitate cognitive growth throughout the brain. Research about the brain and the speed with which neurons are connecting provides further argument about the need to expose these infant implant candidates to a form of visual input, with input through the other senses as well, so that their brains can develop at the rate of a hearing child's brain (Campbell, MacSweeney & Waters, 2007; Musiek, & Daniels, 2010).

Cochlear Implants and Auditory Verbal Therapy

Children born to hearing families will typically be exposed exclusively to spoken language. As mentioned, auditory-verbal therapy is a method of teaching children to use their residual hearing. It is through this type of therapy that families, with the guidance of a therapist, teach their newly implanted child to pay attention to sound over visual stimuli (Harrigan, & Nikolopoulos, 2002). No form of visual communication is supported by this therapy and it is, in fact, highly discouraged. Children in Canada, the US, the UK, Australia and the Nordic countries, in particular, often have speech sessions available through their cochlear implant programs (Einardsdottir, & Wagner, 2006; Tvingstedt, Preisler, & Ahlstrom, 2000). In Canada, more specifically, in Ontario, children of parents who choose an auditory/oral communication

approach are enrolled in auditory-verbal therapy prior to implantation. Estabrooks (2007), at a professional development conference for teachers and speech-language pathologists, noted that “Stimulation of the auditory pathways is needed for the brain to organize itself for receiving spoken language so that cross-modal re-organization does not occur and reduce auditory neural capacity. Normal maturation of the pathways will develop normal speech and language” (Estabrooks, 2007). Other authors use this information as an appropriate argument for introducing sound to the brain prior to 12 months of age (Flexer, 2010; Mayberry, Locke, & Kazmi, 2002; Nishimura et al., 2000). However, while it is true that early auditory stimulation is crucial, it is inappropriate to use this fact as support for the notion that auditory verbal therapy is also necessary for normal maturation of the auditory system; there is no research evidence for this.

Historical Disagreements in Teaching Methods

The historical animosity between the two polar opposite methods of teaching deaf children cannot be ignored. The “oralists” have fought to keep signed languages out of reach for deaf children. The [D]eaf culture groups have felt that their language of instruction is the best way to teach deaf children. Few people continue to use the old Total Communication approach, and to oralists, this highly misunderstood multi-modal approach fits into the signing category. Caught in the middle of the controversy are the families, most of whom are hearing and who do not have experience with the tension between the groups. These families are told by auditory verbal therapists, even prior to implant, when their child is unable to acquire spoken language, that they should not be using any form of visual communication to communicate with their deaf child. Prior to the advent of cochlear implant technology and bilateral cochlear implantation, as well as early identification through newborn hearing screening, serious consideration had to be made as to the ability of a severely-profound deaf child’s ability to communicate using speech even with the best available hearing aids. Children who used spoken language paired with a signed language or who were accustomed to using a signed language primarily, were not considered to be good candidates for implants in the early years, because the visual communication would “compete too strongly with the less familiar spoken form in situations that demand comprehension” (Ling, 1989, p. 151).

Snoddon (2008) reported that auditory-verbal therapists in Ontario, funded by the Infant Hearing Program (IHP), are refusing to treat children who are learning a signed language. Recently, in my practice, I have observed speech-language pathologists who are trained to be auditory-verbal therapists, take a step back and view the communication needs of the child. Consequently, there have been cases recently where my students have been encouraged to use a Total Communication approach prior to obtaining candidacy for a cochlear implant. It is difficult to predict whether similar circumstances are being produced across the province and therefore further data should be collected.

Connectivist Theory

The connectivist theory first proposed in 2004 by Siemens at the University of Manitoba and further expounded by Downes in 2005, describes a model of learning where the learner makes internal connections between ideas throughout their learning networks. The model acknowledges the role of information which is accessed through a variety of resources making connections to other concepts, opinions, experiences and technologies. Existing learning theories such as behaviourist, cognitivist or humanist explain many of the techniques previously used to teach deaf children to speak. However, the learning networks which are central to connectivism can include visual modality, kinesthetic information, emotion, experience and rehearsal. My own method of teaching relies on all of the learning theories to a point. The humanist model is expressed in a focus on having meaningful interactions with infants and toddlers, making these interactions enjoyable and acknowledging that learning only takes place when a child is engaged and interested. Learning through play is a constructivist model where the child constructs new mental models via their experiences and interactions. But these learning theories do not take into account the technological advances of the cochlear implant.

Deaf children are accessing auditory information solely through this technology, and connectivist theory supports the importance of creating and connecting meaningful mental models. External cochlear implant processors digitally synthesize auditory information and send electromagnetic signals to the brain. Herein lies the accessing of information through technology – connecting it to other specialized nodes to synthesize ideas and information. If sign language paired with spoken language on the lips (TC) is

introduced or visual supports were used in the home, what was once represented as a sign or picture becomes connected to the synthesized sound given through technology, and the learner is then able to increase their knowledge of the world and of communication with language. The theory addresses the question of “what adjustments need to be made with learning theories when technology performs many of the cognitive operations previously performed by learners?” (Siemens, 2004).

The connectivist theory supports the need to change the way pre-implemented infants and toddlers are prepared for their technology acquisition, and supports the claim that signing paired with spoken language (TC) could exponentially improve pre-implemented infants’ ability to learn language auditorily. Prior information (knowledge of objects, experiences, communication strategies) stored as nodes within various networks acquired through several types of information sources (nodes- source sign language and spoken language on the lips) and maintained by repeated play (strengthening these connections – constant communication, kinesthetic input, visual input) organized by themes or other patterns could facilitate post-implant sequencing of these networks to new auditory input.

For the post-implemented learner, the connectivist theory proposes that learning is a process of developing a learning network and making connections between ideas embedded throughout the network. It addresses how important technology is in enabling connections where cochlear implants enable auditory connections. It provides a framework for understanding learning using Total Communication to support learning spoken language. “The connectivist theory can inform teaching practices that support learning via connections” (Dunaway, 2011).

All of children’s development, specifically cognition, is shaped by their exposure to a language. Childhood is a time of speedy growth, critical periods of development and learning. The Early Years Study (McCain, Mustard, & Shanker 2007) discussed the rich environments needed to support appropriate neural connections and brain development standing on the notion of critical periods. Though debate around the critical period hypothesis has been ongoing, Bruer (2004) when writing an argument for the Head Start Debates that have moved governments towards all day kindergarten, supports the evidence for critical periods of language development and “component functions within sensory and motor systems”. The “critical period hypothesis”, first proposed by neurologist Wilder Penfield and co-author Laman Roberts in

1959, suggests that unless language learning occurs before a given age, somewhere between 4 and 6 years, there will be considerable deficits in its grammatical fluidity (Penfield & Roberts, 1959).

Moore (2002) reminds us that neural development, as it relates to critical periods, is not simple. The cortex actually matures in “stages/columns”, the first stage of development is complete by 12 months of age. Flexer (2010) argued for early intervention because of the common concept of scaffolding. Flexer describes “Cumulative Practice” as being practice of a skill building on the past practice of it. Mastery of a skill requires repeated practice and is the main growth factor in neuroplasticity of the brain – where neural connections are made in the brain after repeated practice. Connectivist theory supports the building of these neural networks and the strength of nodes relates directly to their use. Critical periods point to the fact that neuroplasticity is strongest at earliest stages of life, anywhere before 42 months (Sharma & Nash, 2009). Children who do not have access to auditory stimulation must rely on their other senses to build skills. Connectivism suggests that once skills have points of departure within the brain, and auditory stimulus becomes available through cochlear implants, then further development and cumulative practice can occur. Networks are formed, connections are made and strengthened. Language gleaned from visual input will have already laid a foundation for language finally accessed through technology auditorily.

Adjusting to Change

Changes in the way therapists and teachers proceed have occurred since paediatric cochlear implantation of the multi-channel devices gained approval (Archbold, 2010). As a group, we must reconsider the child’s age of implantation, the range of access to speech sounds and the digital technology which may be made available to them. Auditory Verbal therapy prior to implantation can serve to prepare families for the post-implant therapy, but must allow for face-to-face communication in the form of a Total Communication approach. Support prior to the surgery should include communication facilitation decided on a child by child basis and TC, which could include flexibility in the amount of visual language, a family’s language of origin and perhaps even picture cues. All things considered, the removal of visual communication in the months prior to implantation as a consequence of the mandates of a 40-year-old therapy that predates cochlear implant advances, is ill advised. The same argument is being made to

support the need for a new theory of learning. Information technology changes the way students learn. Teachers, therapists, librarians all need to adjust to this.

In light of this view on learning, there should be no argument around worrying about an area of the brain not developing. As information is made available, these nodes are connected with prior information (nodes) and the connections form a network. The same can be postulated to occur with all the information taken in through the senses. Teachers and therapists should create opportunities for exposure to sound vibrations if access to useable speech sounds is unavailable. Having face-to-face language such as the described TC to support these experiences may create an exponential learning of speech and spoken language in the future. Pattern recognition from speech reading to speech will occur and make an impact on the quantity of knowledge about language available to the post-implanted child. Consider that without TC, these children may not have access to language until after 14 to 27 months of age.

My Experience with this Case Study

It is questionable as to whether a hearing family, even under perfect immersion conditions, would be able to duplicate the experience of an L1 using a signed language with their deaf infant when they themselves would be learning the language. The conditions met by the family in this case study were such that the visual language consisted of signs and gestures taken from American Sign Language but paired with spoken language to create a visual experience of the English Language on the lips and gestured with the hands, as it would be simplified for communication with an infant or toddler

It is the time prior to implantation that most concerns me, because a significantly long period of time in the short life-span of deaf infants and toddlers prior to implantation can be wasted with no linguistic or language directed cognitive input at all. If children were given the opportunity to learn the language of their caregivers, as it is supported by the signed language of their community along with other sensory inputs, what would be the possible benefits to the child? How would their lifelong learning be affected and how would their language development post-implant be facilitated? A study done by Tait, Lutman and Robinson (2000) in the UK found that modality of language did not affect development of expressive language skills after implantation. Other research from the Ear Foundation in the UK found similar results

(Watson, Hardie, Archbold, & Wheeler, 2008; Watson, Archbold, & Nikolopoulos; 2006). This supports the argument for the use of some signs and gestures, paired with spoken language, in the first year of a deaf child's life. A second report from the Ear Foundation in 2009 suggests that for children with whom a visual modality was used pre-implant, only 30% of users continue to require visual language after implantation (and this study looked at children who would be considered relatively late implanted by today's standards).

Research with hearing toddlers cited by Lederberg and Spencer in 2009, suggests that "rapid word learning" depends on the size of the child's established lexicon, between 20 and 50 words. Children with previously established language are better able to make connection with the words that are being learned and their previous vocabulary. I have observed this same phenomenon with deaf toddlers post-implant. If children have a sign for "dog", when they are hearing the spoken word "dog" paired with the signed word for it, I have observed that they are able to make a connection with the signed modality and the speech sound. Lederberg & Spencer (2000) note that "New words are based on changes in their attention and memory processes derived from regularities in input"(pg. 59). I would argue that consistency of visual language input, paired with whatever auditory information is available to the child with hearing aids, help create these connections. Therefore, given extensive opportunities to see a new word in sign and on the lips and then post-implant, the same extent of experiences to hear it spoken, the ability to expand a deaf child's lexicon post-implant should be facilitated.

Lexicon size is not the only thing that would be affected by the establishment of communication using a TC approach from birth. I propose that concept development, understanding time and routines, making requests, developing eye contact, understanding creative expression in music and rhyme, literacy, turn taking and socialization are all areas of communication that would be positively impacted by allowing visual communication supports from birth. Using a TC philosophy to express these concepts while transitioning to a spoken language post-implant would reduce frustration in both the parent and the child based on the Connectivist theory.

I would argue that parents should seriously consider all of the avenues that might be taken in order to nurture brain development. Thankfully, the plasticity of the brain is well-known to be such and therefore, one could postulate that learning done after implant will positively enhance whatever learning has

been done prior to the implant through the other senses, and should create stronger neurons in the auditory cortex of the brain at first point of input.

Method

This case study focuses on the language development of one deaf premature infant (Matti) pre- and post-implantation with bilateral cochlear implants. Matti, who was born at 27 weeks gestation, weighing 660 grams, is a twin. Both infants remained in hospital for approximately 13 weeks and various interventions related to their prematurity were addressed during the course of this study. However, though one must always consider prematurity as it relates to general development, this study will be focusing primarily on Matti's language development, given that he was profoundly deaf and awaiting a cochlear implant for 16 months. There were four sources of data collected for this study: a structured interview, field notes and observations, formal assessments and reports, and language samples. The study was approved by the Human Participants Research Committee at York University, and written informed consent was obtained from the parents prior to the start of the study.

Participants

Participants in this study were Matti, a male child of twins born following a short pregnancy of 27 weeks, and his parents. Both parents were born and raised in English speaking Canadian homes and are professionals in their fields. They had excellent support from extended family during the months following the delivery of their premature twins.

After a traumatic delivery, the twins were kept in hospital for approximately 13 weeks to deal with various complications around their very early delivery. Through the Infant Hearing Program, and also because of the premature delivery, the boys were screened for hearing loss. Matti was diagnosed with a profound hearing loss at 5 months of age using ABR audiometry. His corrected age would have been 2.5 months of age. The hearing loss was suspected 2 months prior to diagnosis (based on initial screening) but so many additional physical challenges kept the diagnosis on hold. Matti was fitted with binaural hearing aids on September 5th 2008.

The family kept the hearing aids on as much of their son's waking hours as possible, but communicated with him through touch and eye contact immediately. Matti responded so well to eye

contact and imitation of their facial expressions even from 6 months of age. This detail is noted in the field notes that follow in the results section.

During this time, the parents were provided with essentially two communication options, American Sign Language and Auditory-Verbal Therapy. Matti was recommended for bilateral cochlear implants and the parents began to research the process. It was determined, because of their son's very small head size and his additional physical traumas with weight gain and size, that cochlear implantation could not occur until his head size reached a certain diameter.

Awaiting cochlear implantation, the family began to receive weekly auditory verbal therapy. Because Matti did have a profound hearing loss, his participation in listening activities was limited. He relied quite heavily on visual cues and facial expressions. The audiologist noted on one audiogram that he did not have access to speech sounds using the hearing aids. The family noted that their son's success in auditory verbal therapy would have to wait until he received his cochlear implants.

Through weekly visits in the home with this preschool home-visiting teacher, the family agreed to use a variety of means to communicate with their son and to provide language input. At the parents' request, a Total Communication approach, which included natural gestures, some intentionally learned ASL signs, eye contact, visuals and spoken language on the lips were incorporated into communication with their son. The family continued to speak in addition to using signs to communicate simple concepts such as: "all done", "more", "tired", "hungry?". The child related to his world very visually and searched his environment continuously. The family made a point to show Matti where the environmental sounds were coming from. Within our sessions, I would bring along an antiquated tape player to play children's music on at extremely loud volumes. The vibrations were felt easily through this player and the child responded with movement and pleasure.

The home environment was overall, extremely rich and stimulating, with books, developmentally appropriate toys and conversation throughout all parts of the day. During the first year of life, both parents were home for much of the time and the grandparents and aunts and uncles were often part of daily family life to support the busy responsibilities of nurturing the twins in the very early stages of life.

After Matti's implantation, the twins were moved to a local daycare centre. They were there for approximately one year and then moved again to a more convenient centre for the family. In both centers, special care was taken to make the environment quieter for Matti's listening. One must consider, however, that daycare centres are not quiet by nature. During the day at the centre, Matti spent most of his time in a group with his peers. He was withdrawn on a bi-weekly basis for approximately one hour to work either with this teacher in a parent supported session, or with a resource teacher from the community. The teachers at the second centre received training to support their understanding of Matti's listening in their environment and the limitations of the cochlear implant.

It should be noted that during the time of the language development both pre and post implant, Matti had bouts of sickness where he was unable to attend daycare for a week at a time. During these times, he did not receive additional support and the family's resources were concentrated on making his health stronger. It is possible that his prematurity in some ways affected language and motor development.

Structured Interview

The necessary background information was collected through a formal, face to face interview with the parents, but also through field notes and observations. The interview was conducted at the beginning of the study to clarify details that were collected in field notes. Questions addressed during the interview included families sentiments regarding language development, their recollections around the decision to use gestures, visual and kinesthetic supports in addition to the auditory verbal therapy provided through the infant hearing program, post natal details, developmental milestones, home and daycare environment and communication options presented to them (see Appendix B).

Field Notes and Observations

Field notes were taken over the course of 41 months, beginning in October of 2008, when Matti was 9 months old and ending in April 2012 just at the end of his transition to school year. Though the intention for the first year of a home visiting program was to visit on a weekly basis, the majority of the visits did occur on a bi-weekly basis because of the nature of Matti's health. There were times when

weekly visits did occur; however, in the second year of visits, it was the intention to visit on a bi-weekly schedule for approximately 1-2 hours per session. Comprehensive notes were taken during these sessions and included at times, reports from the parents, my observations, and information from the various developmental checklists. During the visits, developmentally appropriate activities were planned using books, craft materials, listening activities such as the tape player with music, puzzles, blocks and natural daily routine activities such as baking or feeding.

Formal Assessments

The SKI*HI Language Development Scale (LDS) (Watkins, 2004), the Listening Skills Scale for Kids with Cochlear Implants (LSSKCI) and the Preschool Language Development Scale-4 (PLS-4) (Zimmerman, Steiner & Pond, 2002) were each administered during the 40 month period. The LDS was updated every 3 months beginning with the first visits and goals for the family were taken directly from this checklist. The LSSKCI was updated every 2 months during the first 6 months prior to implantation. The PLS-4 was administered approximately every 6 months by Matti's speech-language pathologist, who provided me with the results of one assessment.

Both the LDS and the LSSKCI are based on observation combined with parent report. The LDS takes into consideration both visual and auditory communication skills receptively and expressively, where the LSSKCI only considers auditory skills. The PLS-4 is a standardized test of auditory comprehension and expressive communication for infants and toddlers. In younger children, it marks auditory comprehension using comprehension of basic vocabulary. In preschoolers, it searches out skills in more complex language development, communication and inferencing. Expressively, children are required to use their vocabulary to name, describe and compare objects. Older children are required to finish thoughts started and describe visuals seen on a page.

Language Samples

During sessions with Matti in his natural environment (home or daycare), informal language samples were collected spontaneously and occasionally using prompted conversation. Location of visits varied within the home and within the centre, but were primarily confined to a quiet area, often a tabletop or

floor section where focused attention could be developed. It is noted whether additional environmental noises were competing with the communication at hand. Present in all sessions were one or both of the parents, often, Matti's twin brother, and on occasion, an additional adult, being a relative or another support worker.

Formal language samples were obtained during sessions and were recorded using an Ultra Flip video camera resting on the table top about .5 metres from the conversation. Age appropriate materials and stories were used to encourage natural communication, for example, 3-dimensional characters for story retells. Interactions were reviewed and the various phrases were used from the videos to demonstrate the spontaneous language use during play.

Three carefully selected video spoken language samples were evaluated using the TAIT video analysis part of the Nottingham Early Assessment Package (Archbold, Archbold, Gregory, Nikolopoulos, Tail & Tsverik, 2004).

Results

In this section, the findings are reported from the four sources of data collection: structured interview with the parents, field notes and observations, formal assessments, and video recorded language samples.

Structured Interview

Both parents reported that the number one method of communication with Matti, in the first year of life and prior to implantation, was eye contact. The couple agreed that along with gestures, facial expression, pictures, toys, lip reading and some formal signs, it was the eye contact and joint attention that was most important for them. Mother remembered the frustration in the night to soothe Matti and attributed it to the darkness and the inability to access this powerful communication tool. Turning a light on would work against her to help facilitate putting Matti back to sleep, but the darkness removed the access to the communication that worked best.

Along with the eye contact, both parents agreed that other visual cues were fundamental and continue to be fundamental for Matti to understand the environment and the communication given. They both described their use of speech combined with the small repertoire of signs that they had learned. In the interview, the couple was able to brainstorm the formal signs that were used in coordination with natural speech, facial expression and gestures. At first guess, the couple suggested that they had only used 10 formal signs, but with more conversation, the guesstimate got a bit higher with those mentioned to be: water, more, ball, all done, mom, dad, brother, grandma, grandpa, I love you, book, bath, milk, eyes, nose, mouth, moon and possibly some animal signs.

Dad described their communication: "We'd be talking to him, making eye contact and supporting what we were saying with one sign. Gestures that weren't sign language or anything but just motion, not formal, not every word... at that age... we only really needed him to know..." Mom agreed and added: "He could lip read – Dad, [his brother's name], but we did all those signs for mom and dad and he knew those. One of his first words was 'moon'. [I remember he'd] point and sign moon".

When asked why the family chose to learn some formal signs even though they were awaiting a cochlear implant and clearly directed to avoid the visual communication systems, Mom shared candidly:

“[We] went to signing because in case the implant didn’t work. [What if we] weren’t approved for a cochlear? When I started ASL classes, he was deaf. We considered that we may have to move to [another town close to the school for the deaf].” The couple described being cautioned by the psychologist at the cochlear implant program to be prepared for the possibility that the implant would not work. They both described feeling that learning some signs was a fallback position. There was not the thought that using signs would be better for his language learning once implanted, it was just in case the implant didn’t work. They described having met a child where the implant did not work. They did not want to be waiting so long for the implant only to find it did not work and wanted to be prepared either way. Their knowledge of sign was useful to their communication but was also combined with many other visual and kinesthetic resources. English language was continuously the foundation of their communication. The signs, gestures, eye contact and pictures were all supplementary to the English that was being spoken to the twins. It would have been impossible to separate the communication through spoken language from the gestures that were being used, partly because of Matti’s twin brother, but also because English was the language of the home.

Combining signs and gestures with speech was natural for this family. The mother described using songs with gestures and realizing that Matti was learning about language this way. She described singing a song that included the word ‘moon’. This supported their son’s interest in the sign for moon and helped him connect the words in the song to the real-life moon in the sky. As previously mentioned, he would point and sign ‘moon’ when outside. Another song with grand gestures and signs was “Itsy, Bitsy Spider”. Mom felt that having used his songs with gestures, he learned both to lip read and use visual language to create meaning. Though he could not hear the voice, the repeated words on the mouth and simultaneous gestures created a powerful learning experience for Matti.

The father brought up an interesting point in the interview saying that Matti relied heavily on the routine. Dad felt that nearing bedtime it was the pointing, using the bath sign, the eye contact that communicated something powerful, but also the fact that it was a part of their daily routine. In order to maintain communication, even within routine, Dad described the use of the sign for “look”/ “look at this/that” which is the “v handshape” used to point towards your object of conversation. “[Our son] doesn’t like to be touched [to get his attention]. We still use it.”

One of the first things the family did prior to the interview was review their family video collection in order to be able to give accurate recollections of their experiences pre- and post-implantation. Mom described emphatically, that she did not remember him ever babbling. In comparison to his brother, the parents felt that his noises were not really babbling but more screaming and silent bilabial lip smacking noises that he made to feel his drool. He responded and continues to have a strong response to kinesthetic sensations. Both parents agreed that he was mostly silent and he did only things that he could feel. It did not appear that he got any pleasure from hearing his own vocalizations and therefore, he did not really make normal babbling sounds. The mother remembered that he was very loud at night, but felt that these vocalizations were probably because he did not seem to have the same ability to self-soothe that his brother did and he also suffered from reflux at that time. Both parents agreed that if there were vibrations associated with sounds, then he enjoyed them, but he did not notice vibrations from his own voice in order to continue normal babbling.

When describing the difference between easy moments of communication and frustrating times during their days and nights, both parents agreed that Matti thrived on routine and knowing what to expect next. Transitions were very hard for their child to anticipate or understand. They found themselves using photographs to prepare him for car rides. Even up to four months post-implant, both parents admitted that they relied on pictures to get them through the transitions of the day.

As far as communicating with Matti pre-implantation, the couple adamantly responded that most frustrating to them, was soothing him. As previously described, nighttime soothing was nearly impossible in the dark. Mom admitted that she held him to help him fall asleep well into his third year of life. The implant is off when a child sleeps, this lack of auditory communication prior and post implant, in the dark, caused great frustration for this family. Even in the day, the mother described his need to hold her hand for a few minutes at first when the implant is removed. Both parents agreed that it was hardest to comfort their deaf child. The struggle seemed to lie in the inability to say: "it's okay". In explaining Matti's need to be touched during this time, the couple described their use of a weighted blanket, even now, at night. They shared how they are keenly aware of how important the kinesthetic piece was to replace the sense that was

taken away. They listed his ability to feel their heart and humming when held close, his need to watch their mouths and his desperate need to be held tightly.

An interesting side story for Matti is the fact that he has a twin brother who is hearing. When asked about how the boys communicated to each other and how their interactions may have been different because of their twin connection, the parents searched for the correct words. Finally, Mom seemed to settle on describing their communication as such: “[they] read each other, more in synch. [hearing twin] cared – was aware that [his brother] was deaf – made sure that he was able to follow... awareness”. The parents described how their deaf child followed his twin’s lead in routines until he was confident of the routine himself.

After implantation, the couple shared how there was a space in time where Matti awaited a date for having his cochlear implants turned on. Obviously, communication did not change much during this time. Once the implants were turned on, the couple remembered that they still used signs and gestures very much at first. They related about how they had perhaps even signed documents with the hospital to declare that they were not going to use signs with their child. They thought that it may have been a possibility that these documents were related to studies that they were involved in, but even still, they were made very aware of the hospital’s stance on using sign post-implantation. They remember finally having a conversation among themselves about having to stop using the signs. Finally, at 4 months post-implant, the couple remembers making a deliberate decision to be intentional about not signing anymore. They admitted that they felt he would have relied on it had they not “cut it out”. At that same time they stopped using visuals. They shared that they had never used pictures as much as signs and gestures, but they discontinued their use all together in that fourth month post-implant. At that time, they described using gestures “pretty much only when his ears came off”. Dad described giving him 3 auditory tries and then a gesture and Mom remembered using an “auditory sandwich” approach where they would say something, if misunderstood, sign it, and then say it again.

Post-implant and at the time of this interview, both parents described Matti to continue to be very visual. They shared that he relies on his vision to follow what is going on and they know that he misses much incidental language and classroom discussion. His need for the visual input seems to keep him awake

more than his twin brother. He is described to have never napped well and continues to wake up a lot at night. Incidentally, during the interview, the hearing twin came into the room. I asked him if he remembered using any signs such as “more” or “milk” and his response was a blank look at first and a “NO”.

Field Notes and Observations

Table 1 summarizes field notes and observations of Matti’s expressive language and early communication from 6 months of age to 50 months of age. Expressive language and communication was tracked for 41 months at regular intervals during the school year calendar.

Table 1. Expressive and receptive communication and language development

Age	Hearing Age	Nonverbal Communication	Signs and Gestural Communication (Linguistic)	Auditory Responses and Expressive Spoken Language
6 months corrected, 9 mo. chronological	Approx 1 mo (hearing aids)	Eye contact Turn taking (banging on chair arm), pleased with turn taking Laughing out loud		
11 mo. chronological	3 months (hearing aids)	Startled to visual stimulus of puppet opening mouth wide	Closes mouth to food to indicate “no”	
12 mo. (corrected birthday would be April)	4 months (hearing aids)	Looks up to communicate rolling ball back to him as if to say “ready” Initiated imitation game with Grandpa Played peek-a-boo Watches gestures and facial expressions closely	Allows gestures to be made with his hands	Stimulated by the loud vibrating music coming from old tape recorder *likely a vibrotactile response rather than auditory, noticed presence and absence of vibrations
14 months	6 months (hearing)		Gestured: finished, book, hi, bye	

	aids)			
15 months	1 week post implant (no hearing aids, no CIs)		Stops what he is doing frequently to survey the environment New gesture: ball	
15 months	2 weeks post implant	Requested his soother – looked and waited and looked	Gestures: Dad, all done, point, light on, light off	
15 months	3 weeks post implant	Looks at book and back at teacher for the gesture/miming story	Wants names of objects “signed” Watches for gestures in singing	
16 months	1 week with CIs activated			Cries with CIs on Eye widening with loud sound Rocks and claps hands to singing/music
16 months	3 weeks CI age	Bangs cymbals in play		Recognizes sounds: microwave beep, lawn mower, water running Made request with vocalization Alternating vowel sounds are present again
18 months	3 months CI age			Vocalizations: moo, woo woo (woof, woof) oo oo ahh ahh (monkey), wee wee (tweet tweet) Vmmm vmmm, waah wah (talking) Uses both high and low pitch spontaneously but cannot imitate pitch changes yet Imitates reduplicated sounds but with inaccuracies – ahah for oh oh
19 months	3 months CI age			Imitating intonation pitch changes with accuracy Vocalizations: weee! (When we were swinging apple peels) More (word approximation) Heard sauce bubbling on stove, notices all sounds in the environment (loud and soft)

				Requests by vocalizing.
20 months	4 months CI age			<p>Responded appropriately to “run, run, run!”</p> <p>Imitated OOOO by saying MMMMMM</p> <p>Says wawa to request water – prompted by parent asking “do you want some wawa?”</p>
21 months	4 months CI age			<p>Vocalizations: ow ow (oink oink) pointing to pig in book, roar (lion), eow (meow), heh heh heh (dog panting), bye-bye (anticipated the last phrase of the rhyme and filled in those words appropriately)</p> <p>Turns to his own name with accuracy (both full name and shortened form)</p>
21 months	5 months CI age			<p>Spontaneous expressive vocabulary: Eow (meow), up, owp owp (oink oink), ooo ooo (choo choo)</p> <p>Responded appropriately to “give it to daddy”</p>
21 months	5 months CI age			<p>Imitated horse sound</p> <p>Laughs out loud and understands humor</p>
22 months	6 months CI age			<p>Dances along with singing</p> <p>Spontaneous expressive vocabulary: eyes, push, 1-2-3 Go!, pat, pat, pat</p>
23 months	7 months CI age			<p>Spontaneous expressive vocabulary: pig, open, brrrrrr (for cold), yum yum (for food), round and round, help daddy, [brother’s name], egg, owie, eye, nose, water, book, ball open, daddy, boots, please, snow, boat, cow, pig, cat, hat</p> <p>Sings along with familiar songs with some accuracy (e.g. Frosty Snowman song)</p>
2 years today	7 months CI age		Stirring motion mixed with hoo,	Vocalizes to get adult’s attention

video recorded session			<p>hoo to indicate his desire to stir.</p> <p>Reaching for desired object.</p> <p>Wuh! And pointing to indicate all the muffin tins</p>	<p>Spontaneous expressive vocabulary: chee (cheese), pow (smile), ah tie (all done), my, my (protest), buh buh buh (birthday), ah tay (my turn), ah nay nay (protest), han (hands)</p>
24 months	8 months CI age			<p>Spontaneous expressive vocabulary: All done, Hi!, Dool (school), Happy, Sad</p> <p>Many words in play mixed in with unintelligible speech and good intonation pattern</p> <p>Claps and dances to songs.</p> <p>Imitates single words.</p>
26 months	9 months CI age			<p>Saying some two word combinations in play: monkey's jumping (imitation of teacher)</p> <p>Spontaneous expressive vocabulary: Red, book, light, pillow</p>
26 months	10 months CI age			<p>Spontaneous pretend chatting with turtle puppet: pat, squeeze, bye bye turtle</p>
28 months	11 months CI age		<p>Teetah tat (kitty cat) and signed it at the same time</p>	<p>Spontaneous expressive vocabulary: Chi ten (chicken), doddy mine (doggy), tat (cat), da teep (black sheep), tay tay (gold fish) – later said foifish, puninon (put it on), pohwen (children), patky (monkey), elephant (approximation), eyes, tongue, tay tee (one, two), wee (three), inay (lion), pee up (clean up) weesh (squeeze), pee it (peel it), tahtee shhhhh (monkey sleeping)</p>
33 months	17 months CI age			<p>Observations in noisy daycare setting: Heard music from across the room, searched for the source and then began dancing to it.</p> <p>Spontaneous expressive language in play: It's too small, wod did dat?</p>

				why's he crying?, whas a ma sa paydoh (playdoh), Oh where A. go? Oh right dere, shake it please
36 months	19 months CI age			Named all primary colours in play except "yellow" Added the last word to song that had not heard in a year on cue
36 months	20 months CI age			Plural 's' present in running speech Spontaneous language in play: Animals!, frog, horse (for zebra), 3 humps!, a rocket ship, I measure it, I gonna build a house, playing hockey (in response to "what are they doing?"), more measuring (in response to "what is that for?"), [brother's name], where are you? Imitated vocabulary (intelligible): ostrich, tiny, hedgehog, cement truck, vehicle, fork lift, tape measure, pliers, screw driver
37 months	21 months CI age			Spontaneous language in play: That's a baby one, I have two, I smacked it, make another ball daddy Reported to ask "why" often.
38 months	22 months CI age			Spontaneous language in play: I do it!, the piece with the clouds – it okay, Thomas is right there, I found it. Non-looking vocal turns: T: Where is your cottage? C: Beside my home.
39 months	22 months CI age			Spontaneous language in play: Medium sized box, whispers "it's a daddy rabbit", I lop up just like 2 trees, I heard that, that was a flute!
40 months	23 months CI age			Game using sounds, and pictures and recorded voice – able to understand voice but some difficulty identifying sounds like waves splashing, seagull, seal, dolphin.

41 months	24 months CI age			<p>Past tense and future tense verbs are emerging.</p> <p>Uses possessive pronouns well.</p> <p>Tells long stories from pictures.</p>
44 months	27 months CI age			<p>Uses common feelings words</p> <p>Uses texture words hard and soft</p> <p>Uses prepositions under, by, over, below, behind</p> <p>Answers personal questions: How old are you? – 3. What is your mommy's name? - [mom's name]</p>
44 months	27 months CI age			<p>Answers all questions except "how"?</p> <p>Spontaneous language in play: How 'bout...(begins many sentences this way)</p> <p>Age appropriate articulation: k/t, and w/r substitutions; /ng/, /m/, /n/ sounds are clear; blends are mostly correct.</p>
47 months	31 months CI age			<p>Made predictions in story telling.</p> <p>Retold about making a snowman on the week-end and gave details about using chestnuts for buttons.</p> <p>Using – ing, –ed and some irregular past tense.</p> <p>Spontaneous language in play: [girl's name]'s on the sleigh, he must fit in the front, they all fall off, I'm going take off!, they all fall off and the snowman just hopped on and leaves without you guys!</p>
48 months	32 months CI age			<p>Spontaneous language in play: Maybe he must eat people, is a reptile, they're swimming fast, he eats other dinosaurs</p> <p>Can count to 12.</p>
49 months	33			<p>Spontaneous language in play:</p>

	months CI age			<p>Maybe he can belong to the police officer?, Why is she running?</p> <p>Conversations around craft: Teacher: Why do you think I am poking a hole in the bottom? Child: Because the straw has to go through. T: Pick up the shape that works best for the beak. C: a triangle. T: What about the wings? C: a square</p>
50 months	34 months CI age			<p>Spontaneous language in play: Let's sing the alphabet, must push these out because they were on the wrong side, why is nothing coming out?</p>

Table 1 indicates that prior to implantation and in the first year of life, Matti relied primarily on eye contact and visual communication. He demonstrated early communication skills such as turn taking, social humour and found pleasure in interactions with communication partners. At 11 months of age, he had learned how to indicate “no” when related to food. He requested continued action of a familiar toy in a ball rolling game and by 12 months, he was initiating peek-a-boo and seeking out a play partner.

At 12 months of age, Matti began to learn to use signs and gestures. By 14 months, he demonstrated a four-word (sign) vocabulary. By 15 months, he demonstrated a desire to increase his sign vocabulary and watched while being sung to.

Once implanted, the communication changed from being visual and kinesthetic to primarily auditory. Reactions to sound were noted right from one week post-activation of the implant equipment. Music was no longer only a visual and kinesthetic experience and Matti rocked and clapped his hands along with songs. At three weeks post activation, he had already moved to recognizing familiar environmental sounds and making request with vocalizations and babbling. At 3 months post-implant, Matti was making vocalizations similar to that of a 9 month old hearing child and by 4 months post-implant, he was responding to familiar phrases in context, anticipating words in familiar rhymes and turned to his own name with accuracy. Spontaneous speech began to be noted at 6 months post-implant. From that point on, his oral language development grew rapidly and he demonstrated this in his spontaneous speech. There were

limited signs or gestures noted during this time in these observations. It is always interesting to note when the plural 's' is present in a deaf child's vocabulary (as one of the most difficult speech sounds to hear). This was marked at the 20-month post-implant stage where he used age appropriate vocabulary words such as rocket ships and 3 humps.

It is noted at 22 months post-implant that Matti did not need to look up to carry on communication (a behaviour described in the Tait Video Analysis as "non-looking vocal turns"). He answered "where" questions and made comments. At 23 months, Matti was able to listen to non-live (i.e. recorded) voice and make sense of the directions in a game. Articulation was natural and appropriate with speech errors such as "hire hydrant" which could be considered normal. At 34 months hearing age, he was observed using compound and complex sentences, early developing morphological markers, sophisticated vocabulary, and beginning to develop narrative skills.

Matti demonstrated in the chart that he moved from having no access to sound to having full access to sound. His requirement for the visual input was obvious in the first part of the chart and dropped off completely in the notes once he had access to speech through the implant technology. It should be noted that he continues to use visual cues such as assessing a situation or a speaker's tone, using a point and natural gestures. These visual aspects of communication were natural and could be considered normal for hearing children.

Formal Assessments

Both the Language Development Scale and the Preschool Language Sample-4 (PLS-4) were used to assess Matti's receptive and expressive language. The LDS allows the examiner to give credit for signs and gestures as well as speech therefore, deliberate note is made when communication mode are changed and if an auditory approach is being strictly used, credit is not given for signs. It was not until October 2009, 4 months post-implant, when the method of communication actually changed; therefore up until that point, Matti would have received credit for any communication with signs and gestures.

Table 2. Results from the Language Development Scale (LDS)

Date of Assessment	Chronological Age	Hearing Age	Expressive Language (age equivalent)	Receptive Language (age equivalent)
Nov. 12, 2008	9 months	Approx. 1 month with hearing aids	0-2 months	0-2 months
Feb. 17, 2009	13 months	4 months with hearing aids	2-4 months	4-6 months
June 18, 2009	15 months	3 weeks (cochlear implants)	2-4 months	4-6 months
Sept. 16, 2009	18 months	3 months CI age	8-10 months	8-10 months
Oct 21, 2009 *	19 months	4 months CI age	12-14 months	10-12 months
Jan. 19, 2010	24 months	7 months CI age	14-16 months	18-20 months
Nov. 16, 2010	28 months	11 months CI age	20-22 months	20-22 months
Jan. 20, 2011	34 months	17 months CI age	24-28 months	24-28 months
Sept. 15, 2011	36 months	19 months CI age	32-36 months	24-28 months
Feb. 15, 2012	44 months	27 months CI age	36-40 months	36-40 months
April 23, 2012	50 months	33 months CI age	48-54 months	44-48 months

Matti's expressive and receptive language development, pre-implant, were well below normal. At 3 weeks post-implant, there are scattered skills noted on the test form, indicating that Matti was receiving auditory input, however, language skills did not grow significantly this early on. At 3 months post-implant, Matti demonstrated language growth more than 5 months beyond his hearing age. This rate of language development continued into the next month, even though at this point, the family had decided to almost completely drop the signs and other visual supports except as a repair strategy. The growth into the next months demonstrates that Matti was able to switch mode of communication from visual to auditory with relative ease. At 7 months post-implant, language growth was better receptively and is only 4 months behind age-appropriate. Expressively, language development lagged a bit behind receptive but scores continue to be well above his hearing age. At 34 months of age, 17 months post-implant, Matti's expressive and receptive language, are within normal range. He continues to maintain age appropriate levels expressively at 3 years of age. At the final evaluation, with a hearing age of 33 months, Matti's language is age appropriate expressively and only 2 months below age appropriate receptively.

The PLS-4 is used to assess receptive and expressive language skills in infants and young children. There are two subscales: Auditory Comprehension (AC) and Expressive Communication (EC). The PLS-4

also assesses early communication behaviours which are considered to be language precursors. The PLS was administered by the community speech-language pathologist (SLP).

At 29 months of age, and one year post-implant, Matti's language development was assessed at 28 months of age. Compared to results from the earlier PLS-4 findings (previous results were not available for this study), the SLP reported that he made close to 6 months gain in 6 months. At the time of testing, he was using 3 word sentences and 'ing' endings were emerging. Many early grammar forms were present in his speech and he could listen for 2 related items, for example, "get the cow and the pig".

Language Samples

Three language samples were analyzed using the Tait Video Analysis Procedure. Specific to this study, a focus was made to record the number of non-looking turns that were taken during conversations in the language samples.

The first language sample was taken when Matti was 7 months post implant. He was celebrating his 2nd birthday and his father, Matti and I were baking cupcakes for the celebration. The video recording is 7 minutes and 52 seconds long but only a 2 minute clip is analyzed for the sake of comparison with two other clips, which follow. The camera was positioned on the kitchen table facing the child, three feet from his right front side. I was sitting beside the camera on Matti's right front side and the father was moving about in the kitchen on the child's left front side. When the father speaks to Matti, he is next to him on his left front side, within three feet and slightly above eye level. At times, the father is as much as 6 feet away but moves back towards Matti to speak to him or to help throughout the video. There is no background noise apart from the movement of the adults and the materials (pans, paper muffin cups).

During the short, 2-minute clip, the child takes 3 non-looking turns. With the first, he is using the ladle to drop cake batter into the pan and I say: "drop, drop, drop, drop, drop" to which he responds with mouth movements 3 times imitating the "dop" but without a vocalization while continuing to focus visually on his task. For the second non-looking turn, the father is dropping a ladle full of batter into one of the tins and then asks "More?" to which the child responds without looking up: "ah bow" and the father repeats "More.". Also within this video clip, the child has a brief face-to-face conversation about his birthday with

the teacher: "Is it your birthday?" to which he brightens and says: "buh, buh, buh". "How old are you? Say 2!" Matti responds: "dzee!" misunderstanding the question and thinking he was being asked to say "cheese" for the camera. He makes one protest spontaneously about having batter on his hands, which is a strong vocalization with intonation to show displeasure. He comments on the difficulty of the task with an "ahh" vocalization. While dropping batter into the cups, I comment "shake, shake, shake" and the child takes a third non-looking turn without a vocalization but just shakes the arm to drop the batter three times. He followed a point and request "watch daddy" and turns his head to do so.

Interactions in this video clip demonstrate that Matti is hearing and beginning to learn some early spoken language. He hears environmental sounds and searches the environment visually but also responds to repeated short utterances. He has a few learned responses to conversational language.

The second language sample was taken when Matti had a hearing age of 16 months and his chronological age was 2 years, 9 months. The recording captures a session where the mother and child are seated side by side at a small child's table and the teacher is at the end of the table, beside Matti. The camera is situated .5 of a metre from the child so that both mother and child can be seen. Attached to the table, in front of Matti is an apple coring machine, several green apples, some seeds and peels already removed from the apples. The short 1 minute, 56 second clip picks up when Matti is observing the seeds. The vocabulary is new in the context of apples and seeds and the purpose of the lesson was to teach new vocabulary, conversation skills, counting and colours all using a fun, interactive activity that would motivate Matti.

During this video recording, Matti takes 29 non-looking turns and only looks up twice. The first time he looks up is because the mother had been taking conversational turns with him and suddenly, the teacher took a turn. He looked up to see her face and then looked down and made a comment. The second turn was possibly social in nature. During this activity, Matti often repeated what was said in imitation but also commented about what he saw using simple 2 to 3 word phrases. He did not hesitate to use the new vocabulary right away in his conversational language.

The third video recording was taken one year after the second one, when Matti's hearing age was 28 months and chronological age was 45 months. The video recording was 11 minutes and 54 seconds

long. A similar sized portion of this clip was used to count and compare the number of non-looking turns taken and the type of comments Matti made. In this video, Matti is seated in the father's lap with the teacher seated beside them at the head of the table, turning the pages of a simple picture assessment. The teacher engages Matti in most of the conversation while directing him to the photos on the page. During the 2 minutes, 2 second long clip, the child made 21 non-looking vocal turns. In each turn, the child was expressing a unique vocabulary word that matched the picture. On 8 occasions, in addition to the vocal turns, Matti simply shook his head to indicate that he didn't want to respond. He also took 3 turns where he looked up at the teacher while communicating for the purpose of eye contact.

There were consistent, normal language development patterns found in all four sources of data collection (structured parent interview, language tracking through field notes, formal language testing, and language sample analysis). Pre-implantation, Matti relied heavily on his other senses to acquire information about his surroundings and to engage with conversational partners. He searched for eye contact and held it until he was satisfied that he understood. The signs that were learned early on were useful and practical for his age, creating a backdrop to his learning speech later on. Once implanted, Matti's interactions remained partly visual and partly oral for more than six months. The first video recording supported other data where at a hearing age of 7 months, he was able to recognize only familiar words and speech intonation patterns and continued to rely on visual information to supply his needed cognitive understanding. However, 10 months later, there is strong evidence to suggest that Matti learned to gather information almost exclusively through audition in a quiet environment. The visual cues were deliberately dropped and he learned to cope well with the changes of communication strategies. By the first year post-implant, Matti's vocabulary, receptive and expressive language had become age-appropriate and he used his audition as naturally as his hearing age mates. The most important finding in this analysis is that Matti achieved receptive and expressive language auditorily after having had a significant time using a Total Communication approach pre-implantation. The speed with which he adjusted to an auditory communication system suggests that he was not impaired but was perhaps positively impacted in his cognitive development for having used a visual mode of communication while profoundly deaf and pre-implantation.

Discussion and Implications

The purpose of this study was to investigate the effectiveness of using Total Communication, as defined in the background section of this thesis, with a child prior to implantation to support the development of cognition and verbal communication after receiving cochlear implant technology. As previously discussed, it has not been the practice to encourage families to use visual supports and signs with their pre-implanted children. However, it has been my experience that using all of a child's senses to the fullest, supports their understanding of their environment, which further supports their ability to make connections with the listening environment once they have access to sound. This profoundly deaf toddler and his family followed a natural communication procedure, supporting speech through speech reading with some signs throughout most of their child's life prior to receiving the implant. The observations noted were that he showed communication development with signs and speech but that once cochlear implantation occurred and visual supports were put aside, he followed natural language development using his new audition to develop age appropriate language.

The results from this study support the notion that a child who learns to communicate using a visual mode that mirrors the spoken language they are about to learn, can easily transition to spoken language. Prior to implantation, this child's language was delayed until the family decided to begin to introduce signs with speech. According to the SKI-HI Language development scale, the child was still greatly delayed both receptively and expressively, even when given credit for his gestures and signs using this scale which recognizes these methods of communication. However, within 3 months of being implanted, even though the family had supplemented their speech with signs and visual supports, Matti's receptive and expressive language demonstrated 6 months gains expressively and 9 month gains receptively. Within a year of being implanted, he had made such significant gains that his language could be considered age-appropriate according to the PLS-4 test given by his speech-language pathologist.

These data support findings by Lederberg and Spencer (2009) where a child's previously established lexicon of 20 to 50 words support the "rapid word learning" that occurs in hearing children. The estimated number of signs that this child had prior to implantation is between 20 and 50 signs. He demonstrated schema by being able to generalize, recognizing a cow in one book and a 3-D representation

of a cow as a toy. The connectivist theory creates a backdrop to suggest that this child was taking knowledge stored in his mind in the form of signs, speech reading shapes on the face and pictures or toys from play and making connections to speech sounds to quickly build a spoken language from that foundation.

This child demonstrated the typical stages of linguistic development once he had access to audition. He demonstrated the ability to recognize presence and absence of sound in the first video clip and also imitated start/stop patterns such as “drop, drop, drop” without taking a visual turn. This calls into question the belief that children who are allowed to use visual cues post implant will learn to rely on them too heavily and not learn to trust their listening once implanted. The auditory verbal training required by the cochlear implant centers suggests that visual supports such as those used in a Total Communication method described throughout this case study, would negatively impact the development of spoken language after an implant. However, Matti demonstrated that he was able to move quickly through the stages of linguistic development so that one year post-implant, his language was deemed age appropriate.

This case study also supports a study done by Tait, Lutman and Robinson (2000) where modality of language did not affect the benefits of expressive pre-language skills post implantation. It is interesting to note in the recorded interview that the parents made a low estimation of the number of signs that they had used. Four years after the implant surgery, in a formal interview, the family could hardly recall the magnitude of the use of signs and gestures they had used because the signs have been completely dropped from their daily communication. Even when implant technology is removed in their present day, only one signed phrase seems to remain: “look at me!” which they report using when they need Matti to speech read when he is not wearing his implant.

The studies that support the fact that age of implantation has positive effects on language development were a concern for this child when the family knew that some physical factors would restrict him from the early implantation or even from being an implant candidate at all. Our approach to the problem was to support this child using Total Communication as described by Mayer (2012) which permitted the family to be flexible allowing for speaking only, signing only or speaking and signing at the same time depending on the situation. Had the implant technology not worked for their child, I would

argue that they would have already started down a road to communication and would have been able to shift more easily towards learning and using sign language (ASL or a more English-based sign system) as a primary communication system. However, this child was able to use audition well with his cochlear implant, and I would argue that with the foundation laid through visual communication, the child has excellent speech reading skills and English language development.

After implantation, this child benefited from having educated, informed parents who made a deliberate decision to keep his listening equipment on during all waking hours and to make a solid shift over to spoken language. They described using signs in the first month but after 4 months post implant, using only an auditory sandwich approach where the child would be presented with the speech, given the sign only if the speech was not understood and then finishing off with the speech again. This child benefitted from their decisions and demonstrated an accelerated spoken language development once access to speech was in place. As demonstrated in the chart, his communication went from 1) *visual* to 2) *visual and spoken* to 3) *spoken exclusively* in a relatively short time. It is interesting to speculate to what extent the discontinuation of sign was a decision made by the parents, rather than a natural progression towards the exclusive use of spoken language led by the child.

Conditions for language acquisition as outlined by Mayer (2007) were deliberately met pre- and post-implant, as much as possible. Matti had access to spoken language post-implant in quality and quantity by interactions with his twin and his family members and eventually peers in the daycare setting using all sensory modalities possible. Using the cochlear implant, he had access to auditory and linguistic input. The parents were supported by early intervention through home visiting and resource programming. Through this, they were deliberately creating meaningful interactions and using routines and teachable moments to input a variety of vocabulary and concepts.

Finally, the rich interactions that Matti had with others who were capable language users supported his own language development. The overlay of visual to speech allowed the conditions for language acquisition to be met both before and after the cochlear implant was activated, increasing the number of months that the child had really had access to meaningful communication and therefore, brain development.

The results of this study are compelling and since its commencement, I have observed again and again, families who are becoming emboldened by their access to knowledge on the internet and trying this approach with their pre-implanted children (which also relates to the size of our knowledge bases according to the Connectivist theory). However, though I may be able to report other families that do this based on my own experience, the major limitation of this study is its size. Being a single case study, it only demonstrates the need to record more situations where families have had favourable results through the use of Total Communication methods and deliberate language development strategies with our pre-implanted deaf students. It does however; add one more example to the literature of cases where the assertion of auditory verbal therapy proponents that using TC will prevent or impair spoken development has not been shown to be true.

This researcher has observed a shift in services of some pre-implant therapists who are willing to take a closer look at the whole child. It is possible that in time, greater numbers of students may be allowed to receive implants without the strict, debilitating structure of the pre-implant auditory verbal therapy. This is an area of the field where growing pains are being felt and the challenge will be to find researchers who are willing to track and report on the results to bring about change.

The journals contain few Canadian articles on the topic of language development in later implanted children. The shift to implanting children under 12 months of age is relatively new, within the last 5 years or so, and the research base to track the type of systems used to communicate with children pre-implantation is limited. It is also difficult to track language development in babies without having a visual picture of the active sites in their brains. Cognitive development can only be positively affected even in the early months, when access to visual communication is permitted, however, as the Language Development Scale suggested, it is difficult to formally test such a phenomenon in infants and young toddlers. The proof lies only in the skills noted post-implant that are a result of the early visual input as the child develops age appropriate language so quickly after implantation.

Perhaps with the continued development of technology, measuring the gains made in those early years will become more accessible and the theory that connections are being made from visual input, kinesthetic input and finally auditory input will be proven. This study is an effort to suggest there are

benefits to any type of input. Having demonstrated that this deaf child acquired normal language development quickly after bilateral cochlear implants and having used a Total Communication approach, a case can be made to support families in this endeavour in the future, despite opposition in the field.

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Appendix A. Informed Consent Form

Date: _____

Study Name: Spoken Language Development in a Prelingually Deaf Child Where Visual Modality Was Used Prior To Cochlear Implantation – A CASE STUDY

Researcher:

Melanie Simpson – Graduate Student – Masters in Education

Faculty of Graduate Studies in Education at York University

Contact information: Melanie_simpson@edu.yorku.ca or the office of Graduate Studies in Education at 416-736-5018 x. 2100

Sponsor: York University

Purpose of the Research:

The purpose of this case study is to explore the possible benefits of early infant screening, using American Sign Language in the early months before implantation and following that, changing modality to access a second language through cochlear implant technology. The research will rely on field notes and reports from previously conducted sessions with the participant. Findings will be reported in a thesis paper in the form of a case study.

What you will be asked to do in the research:

As participants, you may be asked to provide permission to use information collected by the Preschool Home Visiting Program, Provincial Schools Branch, during teaching sessions with your child and to participate in two, one hour interviews.

Risks and Discomforts:

There are not any anticipated risks or discomforts related to the interview or research process as I seek to use data that has been collected in another context and adult interview data.

Benefits of the Research to the Participant and Benefits to the Researcher:

The case study is an interesting way to view the language development in the context of current research. You may benefit from the research by seeing your child's development in light of the research presented.

The researcher benefits from the study in that it consolidates information that has been informally studied through several years of daily work assignments.

Voluntary Participation:

Your participation in the research is completely voluntary and therefore, you may choose to stop participating at any time. If you choose to stop participating, this decision will not influence their relationship or the nature of their relationship with this researcher or with staff of York University either now or in the future.

Withdrawal from the Study:

You may stop participating in the study at any time, for any reason, if you so decide. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event that you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Confidentiality:

The interview documentation will not be associated with identifying information. The previously recorded sessions of you and your child will be transcribed and not be shared with any party beyond this researcher. The video recordings are stored on a secure hard drive. Hand-written notes will be stored in a locked cabinet. The data will be stored only until the completion of the written thesis. Upon completion, this researcher's copies will be shredded and video recordings will be deleted from the hard drive. Confidentiality will be provided to the fullest extent possible by law.

Questions about the research:

If you have any questions about the research in general or your role in the study, then they should contact myself, Melanie Simpson directly at Melanie_simpson@edu.yorku.ca. Also, you may contact my supervisor, Professor Pam Millett at pmillett@edu.yorku.ca. The Graduate Program office in Education may also be contacted for any further questions at 416-736-5018 x. 2100.

This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics Guidelines. If you have any questions about this process, or about your rights as a participant in this study, you may contact the Senior manager and Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University, telephone 416-736-5914 or email ore@yorku.ca.

Legal Rights and Signatures:

"I _____, signing on behalf of my minor child, consent to participate in Spoken Language Development in a Prelingually Deaf Child Where Visual Modality was Used Prior to Cochlear Implantation – A Case Study. I have understood the nature of this project and wish to participate. I am not waiving any of my legal rights by signing this form. My signature below indicates my consent."

Name of Participant: _____ Date: _____

Signature of Participant's parent: _____ Date: _____

Parent's relationship to the participant: _____

Signature of Principal Investigator: _____ Date: _____

Appendix B. Questions for Interview

1. What type of activities did you find helpful to facilitate communication with your child in the first year of life?
2. Do you remember noticing a period of babbling begin and end with your child?
3. During the second year of life but also prior to implantation, were there particular moments in the day where you felt your communication with your child was most clear and most comfortable?
4. When was communication feel most frustrating during those months?
5. Did you notice that the twin brothers had their own method of communication and if so, how was it different to your communication with your deaf child?
6. After implantation, did you continue to use the same method of communication with your child as you did prior to implantation?
7. How long after the cochlear implant processor was activated, did it take for you to feel with certainty that oral language was allowing clear communication.
8. Were there times in the day where you found yourselves using visual communication more than other times after implantation?